EXHIBIT A SCOPE OF WORK

4 TECHNICAL TASK LIST

Task	CPR	Task Name
#		
1	N/A	Administration
2		Feedstock Preparation
3		PDU Scale Demonstration of SNG Production
4		Basic Engineering Design for the 5 TPD Pilot Plant
5		Feasibility Studies for (1) Algae Feedstock (2) Gasoline Production

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KEY NAME LIST

Task #	Key Personnel	Key Subcontractor	Key Partner(s)
1	Chan Seung Park, UC Riverside		
2	Chan Seung Park, UC Riverside		Food Recycle Science Corp., City of Riverside
3	Chan Seung Park, UC Riverside		
4	Chan Seung Park, UC Riverside, Joe Norbeck, UC Riverside		Food Recycle Science Corp., City of Riverside
5	Joe Norbeck, UC Riverside		

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GLOSSARY:

9 Specific terms and acronyms used throughout this work statement are defined as

10 follows:

Acronym	Definition
°C	Degree Celsius
С	Carbon
CCM	Commission Contract Manager
CE-CERT	UC Riverside's College of Engineering - Center for Environmental Research and Technology
Centi P	Centipoise
CH ₄	Methane
CO	Carbon Monoxide
CO ₂	Carbon Dioxide

CPR	Critical Project Review
Energy	
Commission	California Energy Commission
FT	Fischer-Tropsch
GJ	Gigajoule
H ₂	Hydrogen
HHV	Higher Heating Value
hr	Hour
kg	Kilogram
m	Meter
M	Million
mg/m ³	Milligrams per Cubic Meter
NH ₃	Ammonia
NREL	National Renewable Energy Laboratory
PAC	Project Advisory Committee
PDU	Process Demonstration Unit
PIER	Public Interest Energy Research
ppm	Parts per Million
ppmv	Parts per Million by Volume
SHR	Steam Hydro-Gasification Reaction
SMR	Steam Methane Reformer
SNG	Substituted Natural Gas
SOW	Scope of Work
TAC	Technical Advisory Committee
TPD	Tons Per Day
UC	University of California
UCC.1	Uniform Commercial Code (Financing Statement)
Vol%	Percent Volume
WGS	Water Gas Shift reaction

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Problem Statement

California must produce nearly 2.4 billion gasoline gallon equivalents per year of alternative transportation fuels in order to meet the petroleum reduction objectives of the 2007 State Alternative Fuels Plan. Current annual usage of ethanol is approximately 1 billion gallons, with another 4 million gallons of biodiesel produced (California Biomass Collaborative 2006). Currently, California imports more than 95 percent of the biofuels used in-state. Ramping up in-state biofuel production without competing with existing cropland will be difficult unless other non-crop biomass resources can be used.

A recent California biomass availability assessment found that California generates approximately 83 million dry tons of biomass wastes per year creating various unresolved waste disposal issues for agricultural and forestry biomass residue streams as well as large volumes of biosolids resulting from wastewater treatment facilities. Studies show that 32.1 million dry tons of biomass from agricultural residues is available every year for fuel production when sustainability and harvesting efficiency factors are considered. Further research and development is required to establish commercially-viable waste-to-energy conversion technologies that can simultaneously contribute supplies of renewable transportation fuels and transform waste materials into renewable transportation fuels.

Wet organic waste such as biosolids, food wastes and green/ vegetation waste are important sources of renewable carbon that are under-utilized in the production of biofuels. Currently, most of these wastes are landfilled. The fraction of these wastes generated in California has increased from 23% (2004) to 26% (2008) and is expected to increase more so in the future. These types of wastes tend to have more environmental issues associated with proper disposal compared to other types of waste. Typically, these feedstocks do not lend themselves as feedstock for large capacity commercial facilities because the feedstock amounts needed are seldom available within a reasonable transportation distance. Hence, technologies used to process these feeds must be commercially viable in smaller scales and also be able to accommodate the diverse nature of local feedstocks including ones with high moisture content.

The increasing price of natural gas along with a decreasing supply in California presents a critical need to develop low-cost replacements for natural gas. Thermo-chemical production of Substituted Natural Gas (SNG) from renewable sources offers a viable solution for the concerns of natural gas supply. Unfortunately, conventional processes for SNG production such as anaerobic-digestion and gasification or methanation of partial oxidation product gas have several limitations.

Purpose of the Agreement

This agreement will co-fund the further development of a promising new waste-toenergy technology known as the Steam Hydrogasification Reaction (SHR) process, which has been demonstrated successfully for the production of clean syngas at the Process Demonstration Unit (PDU) scale by the University of California, Riverside's College of Engineering - Center for Environmental Research and Technology (CE-CERT) within the Public Interest Energy Research (PIER) program from the California Energy Commission (Energy Commission).

A PDU scale bubbling fluidized bed SHR, which was developed with previous PIER program support, will be extended to produce the SNG. This task will include: (1) the design, construction and integration of the Water Gas Shift reaction (WGS) with the capacity to handle the producer gas of the SHR, and (2) modification of the feedstock input system to increase the range of feedstock from biosolids to other types of wet feedstock such as food wastes and green wastes.

Goals of the Agreement

The goals of this agreement are to:

- Demonstrate and validate the feedstock pretreatment system to produce a
 pumpable slurry from the comingled biomass/ biosolids, food waste and green
 waste that will be used in the SHR process, achieving a feedstock supply rate of
 0.1 ton per day (10 pounds per hour) for 24 hours of continuous operation.
- Demonstrate and validate the production of SNG with SHR integrated with WGS process from the pretreated feedstock mentioned above. The throughput will be 0.1 ton per day (10 pounds per hour) of feedstock.
- Complete the basic engineering design for a 5 tons/day scale pilot plant using key information obtained through the PDU demonstration.
- Complete the comparison life cycle energy production cost between different technologies to producing SNG from wet organic wastes.
- Complete the feasibility study of algae feedstock for SHR process and new zeolite encapsulated Fischer-Tropsch (FT) catalyst for synthetic gasoline production.

Objectives of the Agreement

The objectives of this agreement are to:

 Validate the performance and product quality of the feed pretreatment process of the PDU under the optimum conditions.

The target specifications for the product composition are:

a) Rheological Properties
Solid loading of the slurry

>30%

Viscosity < 1 centi P

b). Material Loss

CO₂: < 10 Vol% < 10-C6: < 500 ppmv

 Validate the production and quality of SNG from the SHR-WGS integrated process of the PDU under the optimum operating conditions.

The target specifications for the producer gas composition are:

a) <u>Producer Gas Yield and Energy Content</u>
 0.1 MMBtu/hr of SNG from 1 ton per day of raw food waste

b). Producer Gas Composition – dry basis (pre clean-up), H₂-free basis

- Develop the basic engineering design of the 5 tons per day pilot plant to be sited at the wastewater treatment facility in Riverside, CA or at another city site if determined later during the project phase of the program. This basic engineering design of the pilot plant will allow both technical and economic feasibility analysis of a commercial scale process. The design of the pilot plant shall contain the following deliverables.
 - -Block Flow Diagram
 - -Process & Utility Flow Diagrams
 - -Heat & Mass Balances
 - -Plant Layouts & Equipment Arrangement Plan
 - -Equipment, Vessel Specification / List -Long Lead Item List
 - -Estimated Project Cost

Also, complete the comparison life cycle energy production cost between different technologies to producing SNG from wet organic wastes. The result shall contain the following deliverables.

- -Process Higher Heating Value (HHV) efficiency
- -Process Flow Diagram with Mass Balance
- -Production cost as \$/ MMBtu

- Complete the feasibility study of algae feedstock for SHR process. The feasibility study shall contain the following deliverables.
 - -Laboratory scale test result of algae SHR tests including carbon balance and product analysis.
 - -Preliminary estimation of process economics for algae to biofuel pathway.
- Complete the feasibility study of new zeolite encapsulated FT catalyst for synthetic gasoline production. The feasibility study shall contain the following deliverables.
 - -Laboratory scale test result including analysis of synthetic gasoline produced.
 - -Preliminary estimation of process economics for synthetic gasoline production.

Task 1.0 ADMINISTRATION

MEETINGS

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Contractor shall:

Attend a "kick-off" meeting with the Commission Contract Manager, the Contracts
Officer, and a representative of the Accounting Office. The Contractor shall bring
their Project Manager, Contracts Administrator, Accounting Officer, and others
designated by the Commission Contract Manager to this meeting. The
administrative and technical aspects of this Agreement will be discussed at the
meeting. Prior to the kick-off meeting, the Commission Contract Manager will
provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Terms and conditions of the Agreement
- CPRs (Task 1.2)
- Match fund documentation (Task 1.7)
- Permit documentation (Task 1.8)

The technical portion of the meeting shall include, but not be limited to the following:

- The Commission Contract Manager's expectations for accomplishing tasks described in the Scope of Work;
- An updated Schedule of Deliverables
- Progress Reports (Task 1.4)
- Technical Deliverables (Task 1.5)

• Final Report (Task 1.5)

The Commission Contract Manager shall designate the date and location of this meeting.

Contractor Deliverables:

- Updated Schedule of Deliverables
- Updated List of Match Funds
- Updated List of Permits

Commission Contract Manager Deliverables:

Final Report Instructions

Task 1.2 CPR Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and if it should, are there any modifications that need to be made to the tasks, deliverables, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Contractor. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Contract Manager and as shown in the Technical Task List above and in the Schedule of Deliverables. However, the Commission Contract Manager may schedule additional CPRs as necessary, and, if necessary, the budget will be reallocated to cover the additional costs borne by the Contractor, but the overall contract amount will not increase.

Participants include the Commission Contract Manager and the Contractor, and may include the Commission Contracts Officer, the PIER Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Contract Manager to provide support to the Energy Commission.

The Commission Contract Manager shall:

- Determine the location, date and time of each CPR meeting with the Contractor. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Contractor the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this
 meeting will be a schedule for providing the written determination described below.

- Determine whether to continue the project, and if continuing, whether or not to modify the tasks, schedule, deliverables and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the Commission Contract Manager concludes that the project needs a formal amendment or that satisfactory progress is not being made and the project needs to be ended, these conclusions will be referred to the Commission's Research, Development and Demonstration Policy Committee for its concurrence.
- Provide the Contractor with a written determination in accordance with the schedule.
 The written response may include a requirement for the Contractor to revise one or more deliverable(s) that were included in the CPR.

The Contractor shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Contractor Deliverables:

- CPR Report
- CPR deliverables identified in the Scope of Work

Commission Contract Manager Deliverables:

- Agenda and a List of Expected Participants
- Schedule of Written Determination
- Written Determination

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement.

The Contractor shall:

 Meet with the Energy Commission to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Contractor, the Commission Contracts Officer, and the Commission Contract Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting,

which may be two separate meetings at the discretion of the Commission Contract Manager.

The technical portion of the meeting shall present findings, conclusions, and recommended next steps (if any) for the Agreement. The Commission Contract Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Commission Contract Manager and the Contracts Office about the following Agreement closeout items:

- What to do with any state-owned equipment (Options)
- Need to file UCC.1 form re: Energy Commission's interest in patented technology
- Energy Commission's request for specific "generated" data (not already provided in Agreement deliverables)
- Need to document Contractor's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions, such as repayment provisions and confidential deliverables
- Final invoicing and release of retention
- Prepare a schedule for completing the closeout activities for this Agreement

Deliverables:

- Written documentation of meeting agreements and all pertinent information
- Schedule for completing closeout activities

REPORTING

See Exhibit D, Reports/Deliverables/Records.

Task 1.4 Quarterly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement.

The Contractor shall:

 Prepare progress reports which summarize all Agreement activities conducted by the Contractor for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Contract Manager within 10 working days after the end of the reporting period. Attachment A-2, Progress Report Format, provides the recommended specifications.

Quarterly Progress Reports

Task 1.5 Test Plans, Technical Reports and Interim Deliverables

The goal of this task is to set forth the general requirements for submitting test plans, technical reports and other interim deliverables, unless described differently in the Technical Tasks. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index/html

The Contractor shall:

Unless otherwise directed in this Scope of Work, submit a draft of each deliverable
listed in the Technical Tasks to the Commission Contract Manager for review and
comment in accordance with the approved Schedule of Deliverables. The
Commission Contract Manager will provide written comments back to the Contractor
on the draft deliverable within 10 working days of receipt. Once agreement has
been reached on the draft, the Contractor shall submit the final deliverable to the
Commission Contract Manager. The Commission Contract Manager shall provide
written approval of the final deliverable within 5 working days of receipt. Key
elements from this deliverable shall be included in the Final Report for this project.

Task 1.6 Final Report

The goal of this task is to prepare a comprehensive written Final Report that describes the original purpose, approach, results and conclusions of the work done under this Agreement. The Commission Contract Manager will review and approve the Final Report. The Final Report must be completed on or before the termination date of the Agreement. The Final Report Contents and Format, provides the recommended specifications. When creating these deliverables, the Contractor shall use and follow, unless otherwise instructed in writing by the Commission Contract Manager, the latest version of the PIER Style Manual published on the Energy Commission's web site:

http://www.energy.ca.gov/contracts/pier/contractors/index.html

The Final Report shall be a public document. If the Contractor has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Contractor shall perform the following subtasks for both the public and the confidential versions of the Final Report.

Task 1.6.1 Final Report Outline

The Contractor shall:

- Prepare a draft outline of the Final Report.
- Submit the draft outline of Final Report to the Commission Contract Manager for review and approval. The Commission Contract Manager will provide written comments back to the Contractor on the draft outline within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final outline to the Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final outline within 5 working days of receipt.

Deliverables:

- Draft Outline of the Final Report
- Final Outline of the Final Report

Task 1.6.2 Final Report

The Contractor shall:

- Prepare the draft Final Report for this Agreement in accordance with the approved outline.
- Submit the draft Final Report to the Commission Contract Manager for review and comment. The Commission Contract Manager will provide written comments within 10 working days of receipt.
- Once agreement on the draft Final Report has been reached, the Commission Contract Manager shall forward the electronic version of this report for Energy Commission internal approval. Once the approval is given, the Commission Contract Manager shall provide written approval to the Contractor within 5 working days.
- Submit one bound copy of the Final Report with the final invoice.

Deliverables:

- Draft Final Report
- Final Report

MATCH FUNDS, PERMITS, AND ELECTRONIC FILE FORMAT

Task 1.7 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable

through this Agreement. While the PIER budget for this task will be zero dollars, the Contractor may utilize match funds for this task. Match funds shall be spent concurrently or in advance of PIER funds during the term of this Agreement. Match funds must be identified in writing, and the associated commitments obtained before the Contractor can incur any costs for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting.
 - 1. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter.
 - 2. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:
 - A list of the match funds that identifies the:
 - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Contractor shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.
 - A copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.
- Discuss match funds and the implications to the Agreement if they are significantly reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Contract Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Contract Manager within 10 working days if during the course of the Agreement existing match funds are reduced. Reduction in match funds may trigger an additional CPR.

- A letter regarding Match Funds or stating that no Match Funds are provided
- Letter(s) for New Match Funds
- A copy of each Match Fund commitment letter
- Letter that Match Funds were Reduced (if applicable)

Task 1.8 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Permits must be identified in writing before the Contractor can incur any costs related to the use of the permit(s) for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:
 - 1. If there are no permits required at the start of this Agreement, then state such in the letter.
 - 2. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
 - Schedule the Contractor will follow in applying for and obtaining these permits.
- The list of permits and the schedule for obtaining them will be discussed at the kickoff meeting, and a timetable for submitting the updated list, schedule and the copies
 of the permits will be developed. The implications to the Agreement if the permits
 are not obtained in a timely fashion or are denied will also be discussed. If
 applicable, permits will be included as a line item in the progress reports and will be
 a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then
 provide the appropriate information on each permit and an updated schedule to the
 Commission Contract Manager.

- As permits are obtained, send a copy of each approved permit to the Commission Contract Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Contract Manager within 5 working days. Either of these events may trigger an additional CPR.

- A letter documenting the Permits or stating that no Permits are required
- Updated list of Permits as they change during the Term of the Agreement
- Updated schedule for acquiring Permits as it changes during the Term of the Agreement
- A copy of each approved Permit

Task 1.9 Electronic File Format

The goal of this task is to unify the formats of electronic data and documents provided to the Energy Commission as contract deliverables. Another goal is to establish the computer platforms, operating systems and software that will be required to review and approve all software deliverables.

The Contractor shall:

- Deliver documents to the Commission Contract Manager in the following formats:
 - Data sets shall be in Microsoft (MS) Access or MS Excel file format.
 - PC-based text documents shall be in MS Word file format.
 - Documents intended for public distribution shall be in PDF file format, with the native file format provided as well.
 - Project management documents shall be in MS Project file format.
- Request exemptions to the electronic file format in writing at least 90 days before the
 deliverable is submitted.

Deliverables:

• A letter requesting exemption from the Electronic File Format (if applicable)

TAC

Task 1.10 Establish the TAC (The Contract Team will finalize this task and task 1.11)

The goal of this task is to create a technical advisory committee for this Agreement.

The TAC should be composed of diverse professionals. The number can vary depending on potential interest and time availability. The exact composition of the TAC may change as the need warrants. TAC members serve at the discretion of the Commission Contract Manager.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

Researchers knowledgeable about the project subject matter

- Members of the trades who will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives)
- Public Interest Market Transformation Implementers
- Product Developers relevant to project subject matter
- U.S. Department of Energy Research Manager
- Public Interest Environmental Groups
- Utility Representatives
- Members of the relevant technical society committees

The purpose of the TAC is to:

- Provide guidance in research direction. The guidance may include scope of research; research methodologies; timing; coordination with other research. The guidance may be based on:
 - -technical area expertise
 - -knowledge of market applications
 - -linkages between the agreement work and other past, present or future research (both public and private sectors) they are aware of in a particular area.
- Review deliverables. Provide specific suggestions and recommendations for needed adjustments, refinements, or enhancement of the deliverables.
- Evaluate tangible benefits to California of this research and provide recommendations, as needed, to enhance tangible benefits.
- Provide recommendations regarding information dissemination, market pathways or commercialization strategies relevant to the research products.

The Contractor shall:

- Prepare a draft list of potential TAC members that includes name, company, physical and electronic address, and phone number and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting. This list will be discussed at the kick-off meeting and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members and ensure that each individual understands the member obligations described above, as well as the meeting schedule outlined in Task 1.11.
- Prepare the final list of TAC members.
- Submit letters of acceptance or other comparable documentation of commitment for each TAC member.

Deliverables:

- Draft List of TAC Members
- Final List of TAC Members

 Letters of acceptance, or other comparable documentation of commitment for each TAC Member

Task 1.11 Conduct TAC Meetings

The goal of this task is for the TAC to provide strategic guidance to this project by participating in regular meetings or teleconferences.

The Contractor shall:

- Discuss the TAC meeting schedule at the kick-off meeting. The number of face-to-face meetings and teleconferences and the location of TAC meetings shall be determined in consultation with the Commission Contract Manager. This draft schedule shall be presented to the TAC members during recruiting and finalized at the first TAC meeting.
- Organize and lead TAC meetings in accordance with the schedule. Changes to the schedule must be pre-approved in writing by the Commission Contract Manager.
- Prepare TAC meeting agenda(s) with back-up materials for agenda items.
- Prepare TAC meeting summaries, including recommended resolution of major TAC issues.

Deliverables:

- Draft TAC Meeting Schedule
- Final TAC Meeting Schedule
- TAC Meeting Agenda(s) with Back-up Materials for Agenda Items
- Written TAC meeting summaries, including recommended resolution of major TAC issues

TECHNICAL TASKS

The Contractor shall prepare all deliverables in accordance with the requirements in Task 1.5. Deliverables not requiring a draft version are indicated by marking "(no draft)" after the deliverable name.

Task 2 Feedstock Preparation

The goals of this task are to:

- Operate the batch scale hydrothermal feedstock pretreatment system, which was developed in the previous phase of the agreement, to optimize the feedstock preprocessing condition for organic wastes. (Food waste, Biomass, Biosolid).
- Provide enough feedstock for the 0.1 Tons per day SHR PDU for 24 hours of continuous operation.
- Find the optimum process condition which gives higher product specification than the target specification described in the Objectives section of this Scope of Work (SOW).

The Contractor shall:

- Prepare and submit a draft "Feedstock Preparation Test Plan" to demonstrate the proprietary pretreatment process developed by CE-CERT for the organic wastes.
- Modify the draft test plan to incorporate comments by the CCM.
- Operate a batch scale pretreatment process for the organic wastes.
- Collect representative product samples to characterize rheological properties defined in the objective.
- Determine the optimum size and composition of the feedstock slurry to meet the target specification.
- Determine the mass loss during the process.
- Determine the process mass energy balance.
- Prepare and submit an "Optimum Process Conditions Report"
- Prepare a "Pretreatment Process Test Report" containing the discussion of the "Feedstock Preparation Test Plan" results along with recommendations for a larger scale unit.

Deliverables:

- Feedstock Preparation Test Plan (no draft)
- Optimum Process Conditions Report
- Pretreatment Process Test Report (no draft)

Task 3 PDU Scale Demonstration of SNG Production

The goal of this task is to design, fabricate, and operate the WGS Reactor to be attached to the PDU scale SHR Process, which was developed in a previous agreement (Contract #500-09-008) to produce a SNG with the target specification described in the objective section of this SOW.

The Contractor shall:

- Prepare and submit a draft "PDU Demonstration Test Plan" to demonstrate the production of SNG.
- Modify the draft test plan to incorporate comments by the CCM.
- Design the WGS reactor and interface it to an SHR reactor, which was developed for Contract #500-09-008.
- Prepare and submit a "WGS Detailed Design Flowsheet".
- Determine the process mass energy balance.
- Prepare and submit a "Process Mass and Energy Balance Report".
- Operate the integrated SHR-WGS process using the organic waste slurry produced in Task 2.
- Perform parametric testing of the SHR-WGS process. The parametric testing shall evaluate the influence of operating conditions including:
 - WGS Temperature: Evaluate at 250, 300, and 350 °C.
 - Steam/carbon ratio of SHR inlet: Experiments will be conducted at three different steam/carbon feed ratios.
 - Hydrogen/carbon ratio of SHR inlet: Experiments will be conducted at three different hydrogen/carbon feed ratios.

- Based on the parametric testing results, additional tests will be conducted under the ideal conditions to evaluate process efficiency.
- Survey the impurities in the producer gas.
- Prepare and submit a "Process Performance Results Report". The report shall include, but not be limited to: (1) Discussion of the SHR-WGS integrated process technology; (2) Aspen Plus simulation results of the above mentioned process including mass and energy balance; (3) Design of the WGS reactor; (4) Results of the parametric testing of the SHR-WGS process; and (5) Recommendations for the design for the pilot scale process.

- PDU Demonstration Test Plan (no draft)
- WGS Detailed Design Flowsheet
- Process Mass and Energy Balance Report
- Process Performance Results Report (no draft)

Task 4 Basic Engineering Design for the 5 TPD Pilot Plant

The goal of this task is to develop the basic engineering design of the 5 tons per day pilot plant to be sited in a wastewater treatment facility in Riverside, California or at another California city site. This basic engineering design of the pilot plant will allow both technical and economic feasibility analysis of a commercial scale process. This task includes life cycle comparison with other processes for SNG production.

The Contractor shall:

- Prepare and submit a "Block Flow Diagram" showing the finalized mass and energy balance.
- Prepare and submit "Process & Utility Flow Diagrams" for the pilot plant.
- Prepare and submit a "Pilot Plant Design Report" on the project with costs estimates for the pilot plant scale process. The report shall include, but not be limited to:
 - Detailed discussion of the pretreatment process, SHR process, and WGS process.
 - Basic engineering design of the pilot plant.
- Prepare and submit a "Life Cycle Comparison Report" between different technologies for producing SNG from wet organic wastes. The report shall include but not be limited to:
 - Comparison of Process HHV efficiency
 - Process Flow Diagrams of other processes with Mass
 - Balance Comparison of Production cost as \$/MMBtu

Deliverables:

- Block Flow Diagram
- Process & Utility Flow Diagrams
- Pilot Plant Design Report

• Life Cycle Comparison Report

Task 5 Feasibility Studies for (1) Algae Feedstock (2) Gasoline Production

The goals of this task are to:

- Perform the feasibility study of using Algae Feedstock for the SHR process
- Perform the feasibility study of Gasoline Production from Syngas using zeolite encapsulated FT catalyst.

The Contractor shall:

- Prepare and submit an "Algae Feedstock Study Plan" to explore the feasibility of using algae for the process.
- Modify the "Algae Feedstock Study Plan" after review and comment by the CCM.
 The plan will be incorporated into the "Algae Feedstock Study Results Report".
- Prepare and submit a "Gasoline Production Study Plan" to explore the feasibility of gasoline production from the process.
- Modify the "Gasoline Production Study Plan" after review and comment by the CCM. The plan will be incorporated into the "Gasoline Production Study Results Report".
- Prepare and submit an "Algae Feedstock Study Results Report". The report shall include, but not be limited to:
 - Discussion of the algae cultivation and harvesting technology
 - AspenPlus simulation and laboratory scale test results of the Algae SHR process including mass and energy balance
- Prepare and submit the "Gasoline Production Study Results Report". The report shall include, but is not limited to;
 - Discussion of the zeolite encapsulated FT catalyst for gasoline production from syngas
 - AspenPlus simulation results of the gasoline production process including mass and energy balance

Deliverables:

- Algae Feedstock Study Plan (no draft)
- Gasoline Production Study Plan (no draft)
- Algae Feedstock Study Results Report (no draft)
- Gasoline Production Study Results Report (no draft)